LITHOLOGY OF THE SEA-FLOOR OFF SOUTHERN CALIFORNIA

BY

KENNETH ORRIS EMERY
B.S., University of Illinois, 1937
M.S., University of Illinois, 1939

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN GEOLOGY IN THE GRADUATE SCHOOL OF THE UNIVERSITY OF ILLINOIS, 1941

URBANA, ILLINOIS
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ABSTRACT

Description of Area

The sea-floor off southern California is characterized by a submerged Basin and Range type of topography similar to that of Nevada. Structural trends parallel those found on the adjacent coast. Basins and troughs which together comprise about 30% of the area studied have floors of fine-grained sediments. The remaining 70% of the area consists of topographic highs such as banks and shelves on which rock is exposed or is covered by only a thin layer of glauconic foraminiferal sand.

Samples

A total of 132 rock samples from the banks and shelves were studied. Many of these were obtained from outcrops as shown by great cable strain during dredging, by presence of fresh fractures, large individual rocks, general angularity of specimens, or by numerous small fragments of similar lithology. Other samples consist of transported rocks as indicated by rounded shapes and by varied lithology.

Distribution of Rocks

Sedimentary.—Judging from lithologic resemblance to rocks outcropping ashore, the oldest sedimentary rocks are of probable Franciscan (Jurassic?) age. These were found in place only in the western part of the area studied, near the top of the continental slope.

Cretaceous shales were dredged only near San Diego in a submarine canyon. Similarly, Eocene rocks were found only near San Diego and one of the islands, although they are known to outcrop on several other islands.

Miocene limestone, cherts, mudstones, and shales were found very widely distributed especially at the off-shore stations. The age of this material is known both through its content of fossils and by lithologic comparison with material on shore. These

rocks were recovered in abundance on the shelves near Los Angeles and from the bank southeast of San Clemente Island. In smaller quantities Miocene rocks were obtained from many other banks and elevations of the area.

In contrast to the wide distribution of Miocene rocks is the rareness of Pliocene material. Mudstone of this age was found at only four localities.

Igneous.—Granitic rocks were very restricted, being found only as rolled pebbles and cobbles at stations in Santa Monica Bay and vicinity. These were probably transported from mountains ashore. In contrast, andesite and basalt are widely distributed as outcrops, a few fragments of these rocks being present in most of the samples from the off-shore portions of the area. A number of large samples consist entirely of volcanics. Since similar rocks from the islands and the mainland are interbedded with Miocene sediments, it is thought that the sea-floor volcanics are also chiefly of Miocene age.

Metamorphics.—Schists mostly belonging to the Franciscan (Jurassic?) series were recovered in small quantities from a number of stations but were especially abundant from two banks located about thirty miles south of San Clemente Island and from another bank thirty miles southeast of the same island. Schists found on one bank may be of pre-Cambrian age.

Paleogeography

In view of the rarity of Mesozoic sedimentary rocks from the islands as well as from the sea-floor, it is possible that seas during this era failed to cover much of the area studied, although burial by later sediments and volcanics should be considered. Similarly, Eocene seas may have been absent from the central portions of the area.

Considerable more information is available regarding the extent of Miocene seas. Early Miocene like earlier seas may have been restricted or absent from much of this portion of the sea-floor. On the other hand, during the Middle and Late Miocene, the ocean must have covered practically all of the region except local portions which may have supplied sediments to the surrounding areas. Owing to the scarcity of Pliocene sediments,

it seems likely that seas of this age may have been restricted to local basins or if they were more widespread, their sediments must have been removed by erosion.

Time of Canyon Cutting

The youngest rock obtained from the walls of most of the submarine canyons of the area is of Miocene age, but from one canyon Pliocene mudstone was recovered. Since the canyon was presumably cut through this material, the time of canyon cutting is set as post-Pliocene, which checks with data from other sources.

Time of Diastrophism

Because the islands and banks appear to be fault blocks and consist dominantly of Miocene rocks, it seems evident that most of the diastrophism which has affected the area occurred in post-Miocene times. The absence of Pliocene rock on the elevations suggests that the highs may have been initiated near the end of the Miocene leaving the basins as the chief sites of deposition of Pliocene sediments which are now deeply buried. However, uplifted wave-cut terraces on most of the islands and on the mainland indicate much more recent differential movements as does also the present day earthquakes off the coast and in adjacent areas near Los Angeles.

Character of Rocky Surfaces

Since rock is exposed and clastic deposition is not occurring on the tops of elevations off southern California, these environments will presumably produce future unconformities. Just as is true of ancient unconformity surfaces, these areas are characterized by the presence of glauconite and phosphorite nodules, though the age of the latter is not fully known. Rounded pebbles are also found, to depths of as much as 3600 feet. That rounding is not occurring at present is shown by coatings of calcareous organisms, and by films of collophane and manganese oxide on the surfaces of rounded cobbles as well as other rocks. This implies an earlier time of abrasion and transportation which also is indicated by the general flat tops on the banks and by submarine canyons cut into their sides.

VITA

K. O. Emery was born June 6, 1914, in Swift Current, Saskatchewan, Canada, of American parents. He attended grammar schools and high school in Dallas and Fort Worth, Texas, receiving a college scholarship upon graduation in 1932. The first two years of college were spent at North Texas Agricultural College, where he majored in Electrical Engineering. In 1935 he entered the University of Illinois, graduating in June 1937 with high honors in geology. Alternate years of graduate work were spent at the University of Illinois, where in June 1939 the degree of Master of Science was given. During his graduate years, he held one scholarship, two fellowships, and one research assistantship. He is a member of Phi Kappa Phi, Phi Beta Kappa, and Sigma Xi, and an associate member of the Illinois Academy of Science and the Society of Economic Paleontologists and Mineralogists.

Graduate work included two years of research at Scripps Institution of Oceanography, La Jolla, Calif., under the direction of Dr. F. P. Shepard. These two years permitted him to become familiar with methods of study of the geology of the ocean floor and also gave him an opportunity to gather material for theses and other papers. A number of cruises, including one of three months' duration in the Gulf of California, trained him in marine sampling techniques.

His publications include: *Rapid method of mechanical analysis of sands;* Jour. of Sed. Petrology, vol. 8 (1938), pp. 105-111; *Transportation of rock by sea-mammals,* Jour. of Sed. Petrology, in press; and *Rate of retreat of sea-cliffs based on dated inscriptions,* Science, in press. He has also collaborated with F. P. Shepard in *Submarine topography off the California coast; Canyons and tectonic interpretations,* Geol. Soc. of Am. Special Paper No. 31, in press; with F. P. Shepard and E. C. LaFond, in *Ripcurrents—a process of geological importance,* Jour. of Geol., in press; and with B. H. Tschudy in *Transportation of rock by kelp,* Geol. Soc. of Am., in press. Also submitted to the Geol. Soc. of Am. are the following: with F. P. Shepard and R. S. Dietz, *Phosphorite deposits on the sea floor off southern California;* with R. S. Dietz, *A modified coring instrument and the mechanics of sediment coring;* with R. R. Revelle, *Barite concretions from the ocean floor.*